Evidence of Space Weathering Processes Across the Surface of Vesta

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As NASA's Dawn spacecraft explores the surface of Vesta, it has become abundantly clear that Vesta is like no other planetary body visited to date. Dawn is collecting global data at increasingly higher spatial resolution during its one-year orbital mission. The bulk properties of Vesta have previously been linked to the HED meteorites through remote mineral characterization of its surface from Earth-based spectroscopy. A principal puzzle has been why Vesta exhibits relatively unweathered diagnostic optical features compared to other large asteroids. Is this due to the composition of this proto-planet or the space environment at Vesta? Alteration or weathering of materials in space normally develops as the products of several processes accumulate on the surface or in an evolving particulate regolith, transforming the bedrock into fragmental material with properties that may be measurably different from the original. Data from Dawn reveal that the regolith of Vesta is exceptionally diverse. Regional surface units are observed that have not been erased by weathering with time. Several morphologically-fresh craters have excavated bright, mafic-rich materials and exhibit bright ray systems. Some of the larger craters have surrounding subdued regions (often asymmetric) that are lower in albedo and relatively red-sloped in the visible while exhibiting weaker mafic signatures. Several other prominent craters have rim exposures containing very dark material and/or display a system of prominent dark rays. Most, but not all, dark areas associated with craters exhibit significantly lower spectral contrast, suggesting that either a Vesta lithology with an opaque component has been exposed locally or that the surface has been contaminated by a relatively dark impactor. Similarly, most, but not all, bright areas associated with craters exhibit enhanced mafic signatures compared to surroundings. On a regional scale, the large south polar structure and surrounding terrain exhibit relatively strong mafic absorption features, suggesting either a concentration of mafic materials or that materials

exposed have been less affected by space weathering products. These combined initial observations indicate some space weathering processes are active in this part of the main asteroid belt, but are highly variable across the surface of Vesta. Such processes include: impacts from wandering asteroidal debris and local mixing at both micro- and macro-scales, irradiation by solar wind and galactic particles, production and distribution of impact breccias or melt products, and local movement of materials to gravity lows (gradual as well as sudden).